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Sectoral energy consumption in Turkey

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Abstract

Turkey expects a very large growth in energy demand, especially for electricity and natural gas. Today, Turkey's energy production meets nearly 48% of the total primary energy demand. Total primary energy demand will reach 98 Mtoe in 2001 and 308 Mtoe in 2020. Import of primary energy will reach 226 Mtoe and production of primary energy will increase 81 Mtoe in 2020. As seen, Turkey is an importer country for primary energy. Turkey's indigenous energy sources are limited, and the country is heavily dependent on the import of primary energy from abroad. The growth of Turkey's industry is giving rise to a substantial increase in energy demand. In this paper, the primary energy production and sectoral consumption in Turkey is investigated. Further, a sectoral energy demand projection in Turkey is given until 2020. © 2002 Elsevier Science Ltd. All rights reserved.

Keywords: Primary energy; Sectoral energy; Energy consumption; Energy demand; Turkey

1. Introduction

As Turkey's economy has expanded in recent years, the consumption of primary energy has increased. Although Turkey's primary energy resources seem limited, indigeneous energy production meets nearly 48% of the total primary energy demand, but the share of indigenous production is expected to decrease to 26% of the total primary energy supply by 2020 [1]. Given such limited natural resources, Turkey must import most of the energy to meet her needs. Especially, Turkey's economy is dependent on imported oil and natural gas.

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Lignite is the main source of energy produced in Turkey. Today, lignite has the biggest share in total primary energy production by 43%.

The gross electricity production (hydroelectric and thermal) in Turkey reached 116 489 GWh in 1999 [2]. The electricity demand in Turkey has been growing rapidly with the rate of increase of 8% on average for many years [3].

In this paper, the energy production–consumption and demand including the sectors with coal, lignite, oil, natural gas, hydro and electricity, in Turkey will be shown in figures.

2. The situation of energy

Turkey's primary energy sources include hard coal, lignite, asphaltite, bituminuous schist, hydropower, oil, natural gas, nuclear, geothermal, solar, wood, animal and plant wastes. But, the level of primary energy production in Turkey is very low. Due to the very limited indigenous energy resources, Turkey has to import nearly 52% of the energy from abroad to meet her needs.

Coal is a major fuel source for Turkey. Turkey imports over 6 million short tons of hard coal each year, mostly from Australia, the United States, South Africa and Russia. Coal is used mainly for electric power, steelmaking and cement production [4]. Turkish coal consumption has remained roughly stable over the past decade. Turkey is a large producer of lignite. Total lignite reserves are estimated at 8075 million tons, of which 7339 million tons is economically feasible [1,5].

Turkey's oil consumption has increased in recent years, and this trend is expected to continue, with growth of 2–3 percent annually in the coming years [4,6]. Half of Turkey's energy usage is currently oil, but this proportion is expected to decrease somewhat as natural gas usage increases. Current gas production in Turkey meets just 2.8% of domestic consumption requirements [4,6]. Turkey's natural gas resources are small. However, Turkey's natural gas consumption is expected to grow rapidly with 64 bcm (million cubic meters) consumption projected for the year 2020 [1].

Turkey has a gross annual hydro potential of 433 000 GWh, which is almost 1 percent of world total potential. Almost half of the gross potential is technically exploitable, and 28% is economically exploitable. As of November 2000, there were 120 hydro plants in operation [2].

The gross electricity production in Turkey reached 116 489 GWh in 1999. Thermal energy is the source of 70.2% of production, hydroelectric energy makes 29.8%. Coal and lignite accounted for 49.8%, fuel-oil 5.6% and natural gas 31.2% of thermal electricity production. Electricity consumption in Turkey increased to 1840 kWh/person in 1999 [3]. In the future, the construction of 329 more hydro plants is projected for Turkey to make use of the potential remaining hydro sites with a potential of 69 326 GWh/year, which would bring the total number of hydro plants to 483 with a total installed capacity of 34 592 MW [2,4].

Turkey has a large potential for renewable energies. The use of renewable energy sources increases steadily, but remains at low levels. The gross wind energy potential of Turkey is more than 400 billion kWh, of which 124 billion kWh is technically

feasible, and for the same specific locations, the net economic potential reaches about 14 billion kWh [7]. The total solar potential of Turkey is calculated as 88 Mtoe per year [7,8]. Three-fourths of the economically usable potential is efficient for thermal use and the remainder for electricity production [7]. The average solar radiation is 309.6 cal/m^2.day and the average sunshine duration is 7.2 h/day.

Turkey's geothermal potential is nearly 35 600 MW [1,7]. This potential is for thermal use (88%) and electricity production (12%).

3. The sectoral energy production and consumption

Turkey's primary energy sources include hard coal, lignite, oil, natural gas, hydro, geothermal, wood, animal and plant wastes, and solar; secondary energy sources are coke and briquettes. Turkey's primary energy production in the various sources is shown in Fig. 1[1,9]. As can be seen, lignite is the major primary energy source in Turkey. Turkey's oil and natural gas reserves seem limited, coal reserves are quite abundant. Lignite accounts for 43 percent of Turkey's total primary energy resources, while oil and natural gas accounts for 13 percent and 1 percent, respectively [1,10,11].

Turkey's primary energy consumption is shown in Fig. 2[1,12]. As shown in the figure, oil, coal and natural gas are the major primary energy consumption in Turkey. The primary energy consumption is dominated by oil with a share of 46% and natural gas with a share of 12% [1,10].

Figure 3 shows the total energy consumption by sector for the period 1980 to 1996 [1]. The household and industrial sectors have the highest share of primary energy consumption. The transportation sector ranks second in energy consumption. The final consumption of energy for each sector in 1996 is the household sector

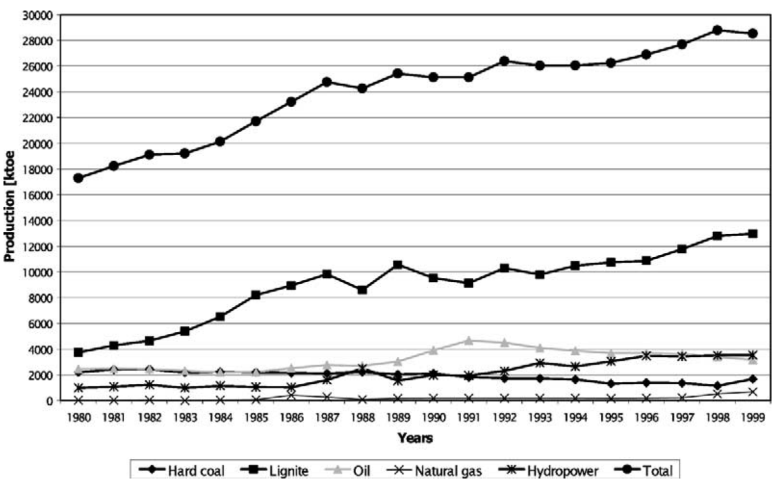


Fig. 1. Turkey's primary energy production during 1980–1999 [1,9].

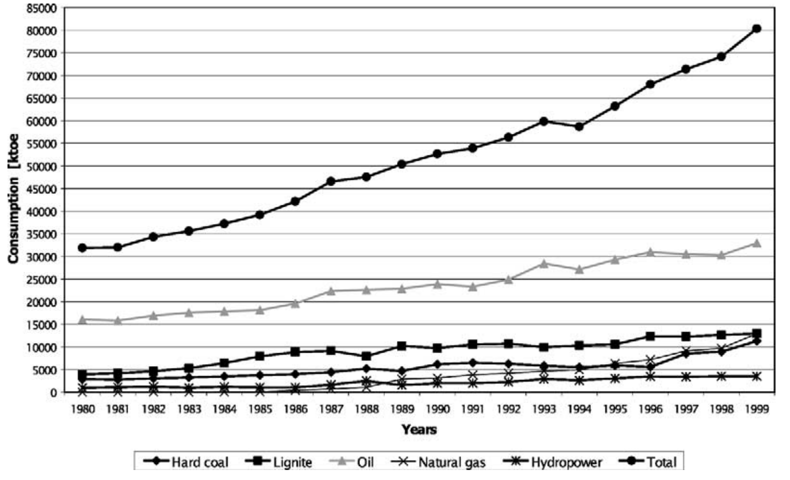


Fig. 2. Turkey's primary energy consumption during 1980–1999 [1].

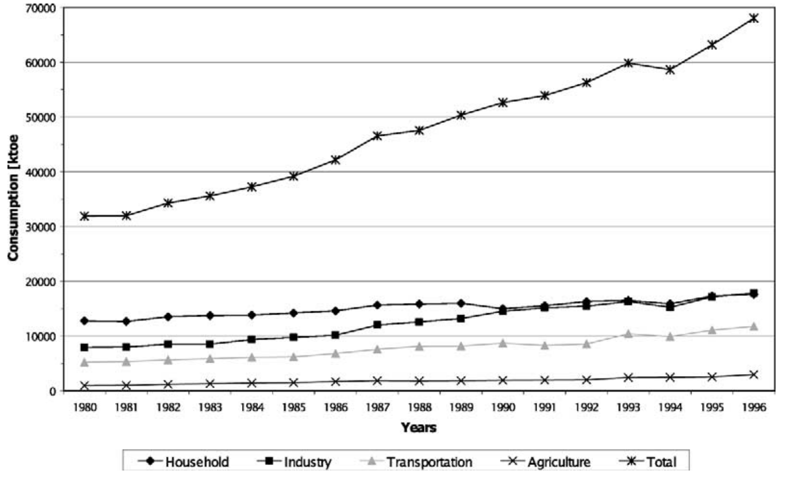


Fig. 3. Total energy consumption in the sectors in Turkey during 1980–1996 [1].

25.9%, the industrial sector 26.3%, the transportation sector 17.3% and the agriculture sector 3.9% [1]. The total electricity consumption in the sectors in Turkey is shown in Fig. 4 [1]. If classified by consumption in each sector, for the total generated electricity of 116 489 GWh in 1999, 53.9% was used by the industrial sector, 42.0% by households and government offices, 2% by agriculture and 0.7% by the transportation sector [1].

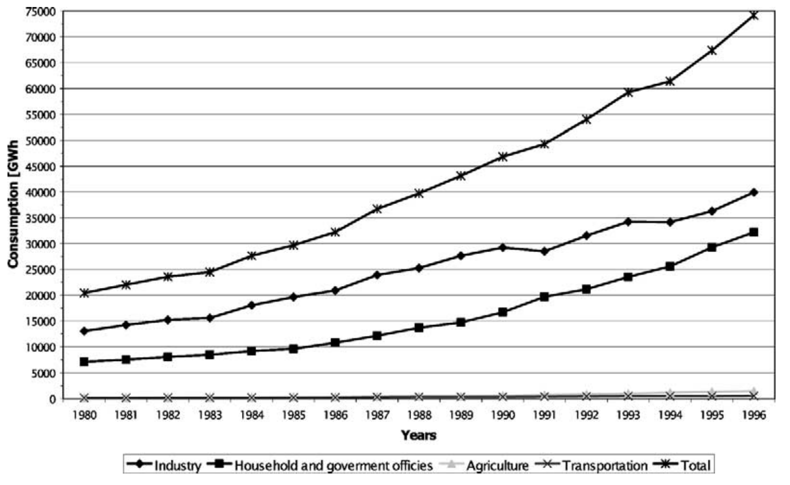


Fig. 4. The gross electricity consumption in the sectors in Turkey during 1980–1996 [1] .

4. Turkey's energy demand and discussion

Turkey is heavily dependent on the import of primary energy sources from abroad. Especially, Turkey is heavily dependent on imported oil and gas. This trend is likely to continue in the near future. Turkey's total primary energy production demand will reach 98 Mtoe in 2001 and 308 Mtoe in 2020. In Turkey, the import of primary energy will reach 226 Mtoe and the production of primary energy will increase 81 Mtoe in 2020. The share of imports is expected to continue to grow from 67% in 2001 to 74% in 2020.

Half of Turkey's energy usage is currently oil, but natural gas usage is increasing. But the share of natural gas has been negligible in the total primary energy production. Oil has the biggest share of 44% in total primary energy consumption, while natural gas has a share of 12% [11]. Turkey's natural gas consumption has been gradually rising since the mid-1980s. It is expected that the demand for natural gas will reach 25–30 bcm and 60–65 bcm in 2001 and 2020, respectively. The annual oil consumption of Turkey is around 28.3 million tons. While 82% of total consumption is supplied from imports, only 18% is supplied from indigeneous production [11]. The demand for oil is projected to increase from 39 Mtoe in 2001 to 78 Mtoe in 2020.

Turkey is a large producer of lignite. Total lignite reserves are estimated at 8075 million tons, of which 7339 million tons are economically feasible. Turkey's lignite deposits represent 40% of total primary energy [1,5]. The electricity generation sector represents the major energy consuming sector in Turkey's lignite consumption.

Figure 5 shows the primary energy consumption in the household sector for various energy sources. It is seen that wood consumption represents the major energy source in Turkey's household sector. But natural gas consumption is growing rapidly. The household sector consumed 17.63 Mtoe in 1996 [1].

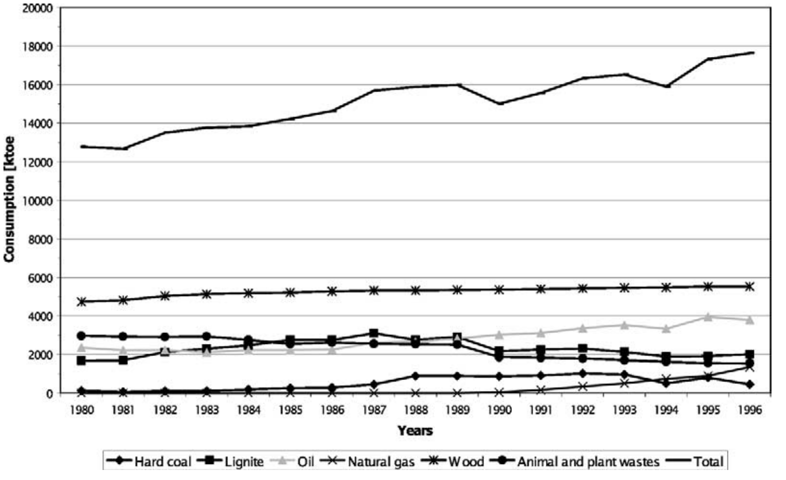


Fig. 5. Primary energy consumption in the household sector during 1980–1996 [1].

The primary energy consumption in the agricultural sector for various energy sources is shown in Fig. 6 [1]. As can be seen, electricity consumption is very small and nearly all the consumption is oil in the agricultural sector in Turkey. Oil consumption is increasing rapidly. Figure 7 shows the primary energy consumption in the transportation sector for various energy sources. It can be seen that oil has the highest share (99.5% in 1996) in the energy consumption [1]. The primary energy consumption in the industrial sector for various energy sources is shown in Fig. 8 [1]. Oil, electricity, lignite and coke are the main energy sources utilized in the industrial sector. But natural gas consumption is increasing rapidly in this sector.

Figure 9 shows the distribution of primary energy consumption in the industrial

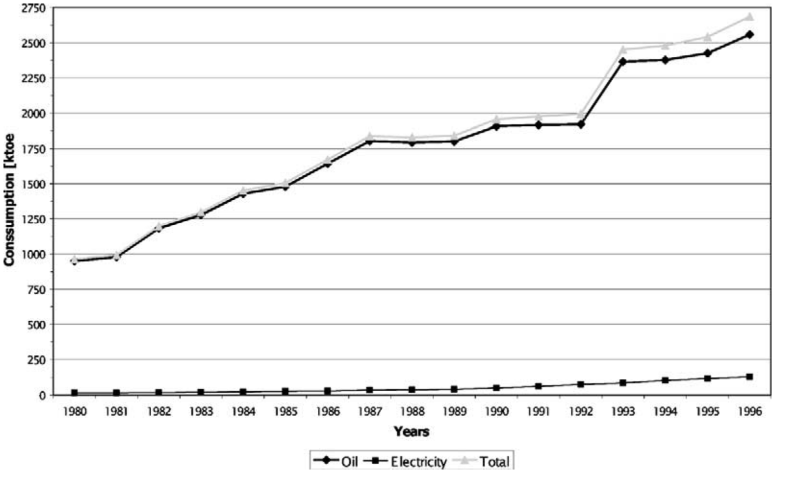


Fig. 6. Primary energy consumption in the agriculture sector during 1980–1996 [1].

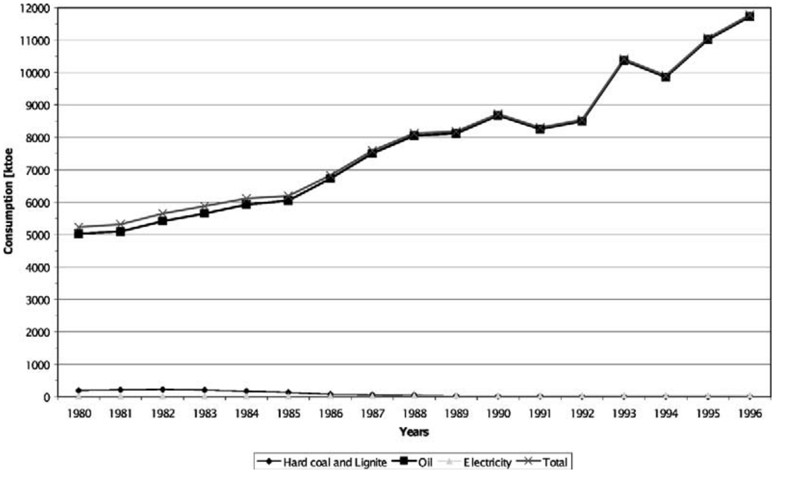


Fig. 7. Primary energy consumption in the transportation sector during 1980–1996 [1].

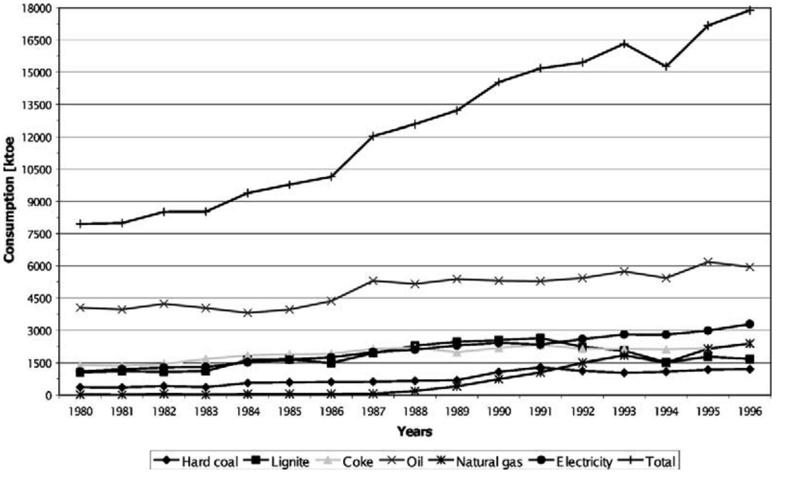


Fig. 8. Primary energy consumption in the industrial sector during 1980–1996 [1].

sector during 1980–1996 [1]. This sector includes iron–steel, chemical and petrochemical, petrochemical feedstock, fertilizer, cement, sugar, non-ferrous metals and other industrial branches. The iron–steel and cement industries have the highest energy consumptions. Other energy consumption sectors are petrochemical feedstock and chemical and petrochemical. If classified by consumption by sector, the total industrial sector used 17.884 Mtoe in 1996, of which 19.6% was used by iron–steel, 6.8% by chemical and petrochemical, 8.7% by petrochemical feedstock, 5.2% by fertilizer, 15% by cement, 3.2% by sugar, 3.5% by non-ferrous metals and 38% by others.

The sectoral distribution of the primary energy demand in Turkey is shown in

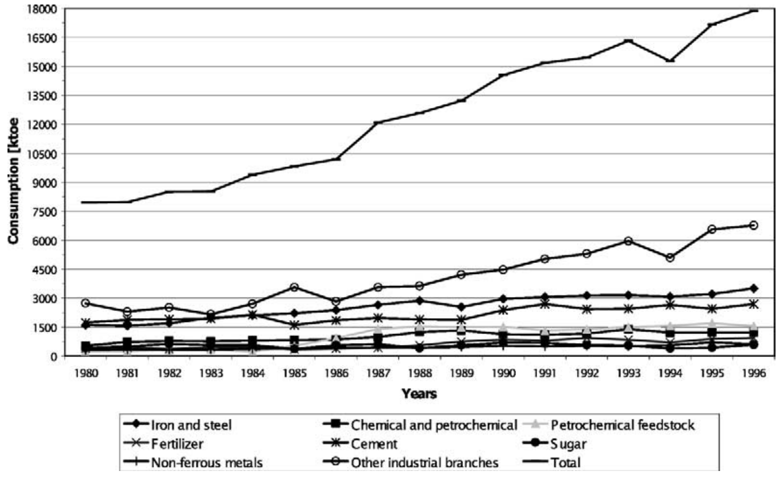


Fig. 9. Distribution of primary energy consumption in the industrial sector [1].

Fig. 10 [1]. As shown in the figure, the industrial sector has the highest share in the primary energy demand in Turkey for the years 2001–2020. By the year 2020, the energy share of the industrial sector will be around 127 Mtoe. Industrial, household and transport sectors are the main energy consuming sectors in Turkey. The average percentages of primary energy demand in the sectors of industry, household, transportation and agriculture are 41.3, 15.6, 12.9, and 2.7, respectively, in 2020, as shown the figure.

Turkey's total electricity generation was nearly 125 TWh in 2001. Electricity generation demand will increase to 492 TWh in 2020. Turkey plans to increase hydropower production in the near future. Electricity consumption in Turkey increased to

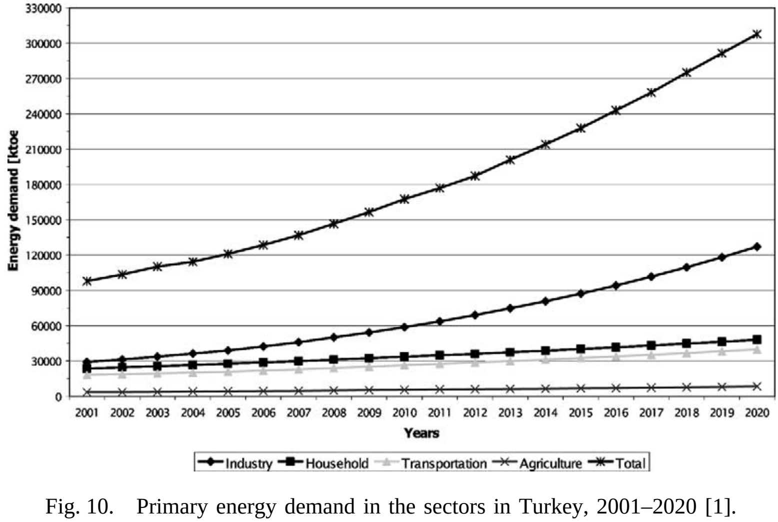


Fig. 10. Primary energy demand in the sectors in Turkey, 2001–2020 [1].

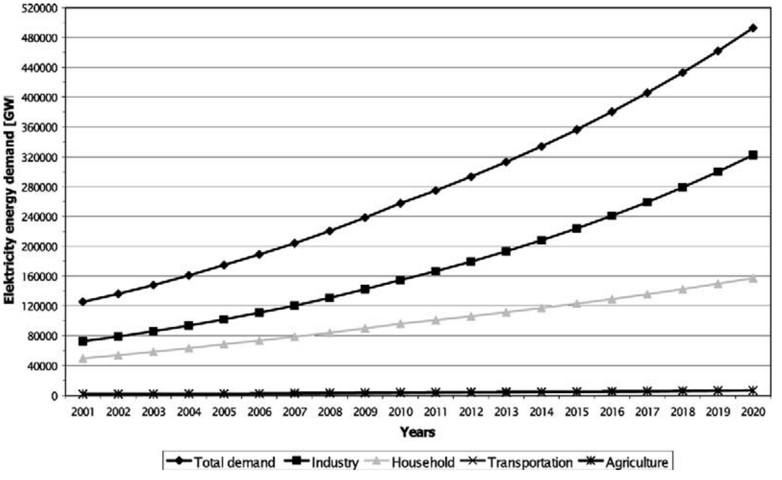


Fig. 11. Turkey’s electricity consumption demand forecast, 2001–2020 [1].

1840 kWh/person in 1999. It is expected that the consumption will reach 2773 kWh/person in 2005 [12]. There is no nuclear power in Turkey as yet. But some new nuclear plants are expected to be built in Turkey during the outlook period [12].

Turkey’s electricity consumption demand forecast for 2001–2020 is shown in Fig. 11 [1]. Electricity is a major component of increased energy demand in the industry and household sectors. The share of illumination within the electricity consumption is increasing every year. Electricity demand in Turkey is growing rapidly with the rate of increase of 8% on average for many years. As can be seen, the electricity demand will increase to 125 TWh by 2001 and to 492 TWh by 2020.

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